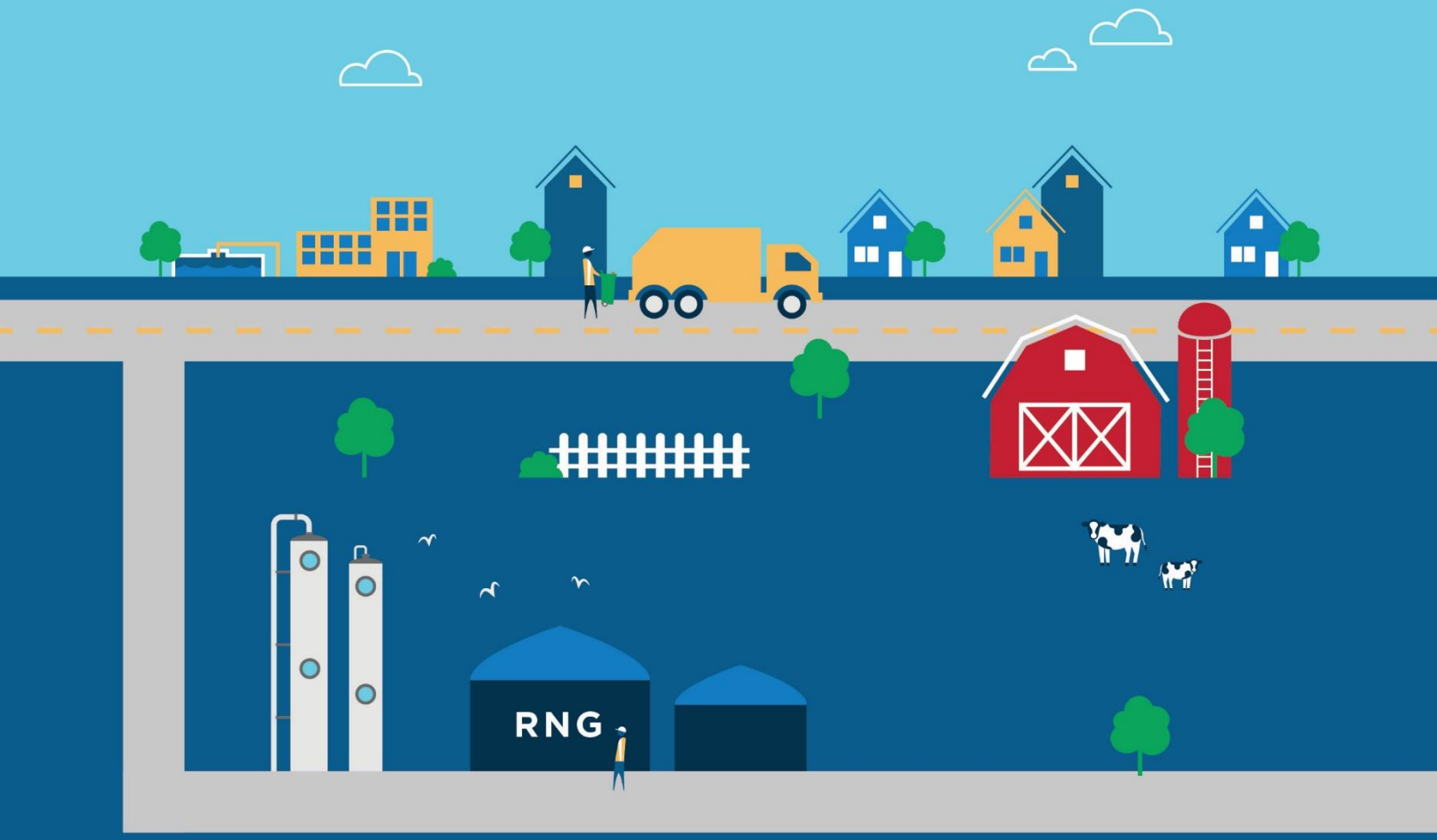
Federal Policy Proposal

The Canadian Renewable Gas Innovation Program



August 2018

CANADIAN GAS ASSOCIATION
ASSOCIATION CANADIENNE DU GAZ

Table of Contents

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Executive Summary

This proposal seeks a federal government allocation of $750 million to support renewable gas project deployment, technology commercialization, and the enhancement of federal and academic renewable gas RD&D capacity across Canada. A Canadian Renewable Gas Innovation Program ("the Fund") would bring in new supplies of renewable gases and connect it to the Canadian gas infrastructure network positioning Canada as a global leader in renewable gases.

As a result, Canada will realize significant GHG emission reductions of 14 MT[1] (if a ~5% blend in the gas infrastructure system is achieved) that will contribute to Canada's 2030 GHG targets set in 2015. As highlighted in the Generation Energy Advisory Council report, oil and gas will remain the dominant fuel source in Canada and as a country we are aiming to become the world's cleanest producer of liquefied natural gas. One such pathway to succeed in this vision is to include renewable gases in the existing mix of natural gas supply in Canada. Generation Energy notes the important role of RNG and hydrogen as clean energy sources for Canada.

Improving Canadian competiveness is the central focus of the Fund. Improved competiveness will be achieved by positioning Canadian industry and clean technology exporters as leaders in the production and use of renewable gases. The Fund will focus on the technology demonstration and commercialization of three forms of this resource: RNG or renewable natural gas (gasification and anaerobic digestion), hydrogen, and synthetic methane. All three forms of renewable gas can be blended (at varying percentages) into the natural gas pipeline system.

The Fund would have a six (6) year program duration[2], starting in fiscal year 2019/2020. The Fund will be structured such that successful projects[3] that are profitable will be responsible for repayment of the federal funding they receive. Federal funding would account for between 30-50% of a project. The balance of capital needed for a given project would include private lending, provincial and utility rate payer contributions, and funds raised by Canadian small and medium clean technology companies. All of these separate investments create economic activity across multiple chains of the Canadian economy.

The Fund would help further Canada's position as a world leader[4] in low emission natural gas infrastructure systems. Around the world, leading economies such as Germany, France, Italy and the United States are all advancing policies that support broad- scale introduction of renewable gases into the existing natural gas pipeline network. These countries have rightly realized that in order to achieve a lower emission future, gaseous infrastructure will be essential. There are over 500 projects in Europe, and there are 50 in the United States. At present, Canada has just 11 projects operating. Further, unlike renewable liquid fuels which are produced and traded globally (of which Canada imports a significant volume to meet low carbon fuel regulations), the economic benefits of renewable gas project construction accrue to the country in which the policy is introduced. This means that a Canadian policy would create first of kind transactional relationships between Canadian natural gas companies and feedstock owners including forestry and agricultural operators, electricity operators (in the case of hydrogen power to gas[5]), municipalities (with landfills and waste water) and Indigenous Communities.

The Fund would create new and meaningful collaborations and joint ventures between government, private industry, and academia. Canada has a strong history of leading on energy innovation including Candu

[1] ICF International: file:///C:/Users/pcheliak/Downloads/ICF-Report-Reducing-GHG-Emissions-Final-2016.pdf
[2] Fund duration is still TBD depending on whether a production incentive is an available fiscal option.
[3] Note: Only TRL 8-9 projects, and Stream 2 commercialization recipients, would have a repayment requirement.
[4] See Appendix 1 for a detailed list of Countries with renewable gas policies in place.
[5] See Appendix 2 for a description of power to gas and for information on a North American Hydrogen Task Force.

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reactors in the 1950's, oil sands in the 1970's, condensing furnaces in the 1990's, heat pumps in the 2000's and net zero homes today. Looking forward, the Fund will help position Canada as a leader in the global movement for the production, integration and use of renewable gaseous fuels and will support our energy, climate and clean technology export policy objectives.

The potential role for renewables gases in Canada is clear: it is identical with the role of natural gas today. In 2017, natural gas provided Canadians with 34% of their energy needs. Natural gas is delivered to over 20 million Canadians through over 500,000 kilometers of infrastructure. The National Energy Board forecasts that natural gas will become the single largest source of energy in Canada by 2040 surpassing refined petroleum products for the first time. Globally, the International Energy Agency forecasts natural gas demand will increase 45% by 2040. The expanded use of natural gas, both domestically and globally, points to the foundational role it will continue to play in meeting global energy needs. Further, the natural gas industry is committed to working with governments to deliver cost effective, timely GHG emission reductions that will contribute towards Paris 2030 targets. At the same time, Canadian energy and environmental policy must strive at all times to preserve Canadian competitiveness.

By enabling Canada's manufacturing and energy sectors to use a lower emitting supply of natural gas, they will be better positioned in a growing global marketplace for sustainable product development and low emitting goods and services. The Fund also sets out with the intention of positioning Canadian companies for success as they look to develop next generation renewable gas technology export solutions to meet the needs of a rapidly expanding global market for renewable gaseous solutions. At the same time, the Fund will deliver GHG emission reduction benefits and support key federal policy objectives including the clean fuel standard (by providing an improved pathway for natural gas credit generation and compliance) and methane emission reductions (by capturing methane emissions from forestry and agriculture waste streams). Further, because renewable gases are carbon dioxide neutral, they respond to and mitigate the impact of carbon pricing on fuel users. Finally, renewable gases offer a pathway for zero emissions freight transportation, the fastest growing source of transportation emissions in Canada.

With respect to next steps, CGA has made a federal pre-budget submission (August 3, 2018) that included a renewable gas funding request of $750 million. Over the course of the summer/fall 2018, we will continue to consult and incorporate perspectives of government officials, natural gas value chain companies, natural gas consumers, the renewable gas industry (technology providers, vendors), feedstock suppliers (municipalities, forestry companies, and agricultural companies) and environmental non-governmental organizations. Further, CGA will meet with and brief Parliamentarians on the proposal alongside a social media campaign on renewable gases starting in September 2018 and continuing through to early 2019.

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Policy Goals and Vision

The overarching goals of this proposed policy are to improve Canadian economic competiveness; reduce GHG emissions and support clean fuel standard credit generation; facilitate the establishment of first-of-kind collaborations in renewable gas production; provide new market opportunities for Indigenous Communities, municipalities, agricultural producers and forestry companies; and accelerate the commercialization of new renewable gas technologies. The vision for this policy is that it will stimulate a market and put Canada on course to realize between 5-10% content of renewable gases in the Canadian energy system by 2030[6] and bring about a reduction in renewable gas costs of 25-30%. Further, the policy, via its technology component, will attract, over the medium term, new capital into Canada that will support next generation renewable gas patents and export opportunities. Finally, the policy will bring much needed federal leadership and policy stability for renewable gases in the same way federal leadership was needed for renewable liquid fuels.

The Policy Funding Streams

The Fund would have two separate streams. For both streams, a stated goal is to support Canadian manufacturers of renewable gas technology solutions and equipment:

(1) Renewable Gas Technology Commercialization Fund (total: $175 million over 6 years). This fund would include two separate funding blocks; a $150 million Technology Demonstration Fund; and a $25 million Laboratory Fund.

The Technology Demonstration Fund would support $150 million in renewable gas technology demonstrations across Canada. Funding would be awarded to innovative project concepts[7] including commercial scale renewable gas production and end use demonstrations (e.g., RNG or hydrogen networks feeding dedicated end uses, including transportation), agricultural/forestry waste gasification projects, co-digestion of feedstocks (e.g., biomass and municipal waste), and next generation renewable gas clean up technologies (e.g., advanced tar removal, low cost membranes, etc).

It is proposed that the Natural Gas Innovation Fund (NGIF)[8] act as the third party vehicle for delivery of the $150 million in partnership with Natural Resources Canada (NRCan). NGIF is an industry-led funding organization with a rigorous, fair and transparent due diligence process comparable in principle to Natural Resources Canada funding programs for assessing, approving and managing projects, and reporting on results from Government contributions. In addition, NGIF has trusted partnerships in place with federal and provincial funding agencies for the confidential sharing of information to streamline the co-funding of gas technology projects. NRCan and NGIF would launch joint funding calls and open competitions soliciting project opportunities for the de-risking of renewable gas technology providers that can demonstrate a strong value proposition for innovation, a highly skilled team, a sound business model, strong commercial uptake and good policy alignment. Funding decisions would be made by both NRCan and NGIF/industry. Funding amounts would include up to 30% of eligible project costs[9] in the form of non-repayable grants for technology demonstrations with Technology Readiness Levels (TRL 4-7) and up to 50% of eligible project cost in the form of

[6] In 2016, CGA publically endorsed an aspirational goal of 5% by 2025 and10% RNG by 2030. This goal remains in place but includes other renewables as well. More recently, BC and QC have looked at 5% blends by 2030. Therefore, for the purposes of this policy proposal, a blend rate of 5% is used to generate various facts and figures.
[7] This listing is not exhaustive. There are a multitude of different project concepts that would be eligible.
[8] http://www.ngif.ca/
[9] Project cost eligibility would be detailed in a Contribution Agreement and would follow existing NRCan eligible cost criteria.

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repayable loans[10] for first of kind commercial demonstrations (TRL 8-9).

The Laboratory Fund would see an allocation of $15 million to support the creation of a world class hub for renewable gases at CanmetENERGY federal laboratories in Ottawa and $10 million would be made available via competitive process for collaborative academia/government/industry support that addresses specific gaps in capacity building, codes and standards[11] and bench scale research. In an effort to effectively target funds where they are most needed, the Government of Canada (select departments, TBD) would collaborate with industry (over the fall/winter of 2018/19) to conduct a pan Canadian renewable gas R&D/technology needs assessment. From that assessment, the funding priorities would be determined. Ultimately, strategic laboratory enhancements would play an important role in providing both domestic and global renewable gas technology manufacturers with a Canadian-led renewable 'hub' to test and collaborate along the renewable gas value chain. At the same time, industry recognizes the important role government laboratories play in the innovation value chain by providing important third party, non-biased research capabilities combined with a recognized reputation and brand.

(2) Renewable Gas Commercialization Fund ($575 million). The Fund, to be managed by NRCan, would support repayable financing of renewable gas projects of up to $25 million per project[12]. The project applicant would have three separate funding options available. These options are meant to address local policy and market needs. The project proponent would select their preferred option.

a. Option A is a production incentive. In this scenario, a producer of renewable gases would have a pre-determined value ($TBD/GJ or equivalent) attributed to their renewable gas production volume. This term of the incentive would have a minimum of 5 years[13] and may include a sliding scale where the initial contribution is higher and declines over time. Projects that can demonstrate a lower GHG profile renewable gas will secure a higher production incentive. This will incent projects with the greatest GHG impact.
b. Option B is a capital cost contribution to a project. In this scenario, a project developer may already have a long term production incentive with a gas utility but is looking to 'buy down' the price of that contract. Option B does that. In doing so, Option B allows the utility to further the reach of their renewable gas program and also allows the developer to secure early stage repayable grant funding to build their project. This funding limits exposure to non-government (e.g., lending institution) interest/borrowing costs.
c. Option C is hybrid of A and B. This option would see a smaller capital cost contribution combined with a smaller production incentive. In this scenario, the proponent seeks to diversify their funding approach.

In all three cases, the value of funds provide to the project would be the same. No one option will be more financially beneficial than another. As noted, the maximum total federal contribution for any of the options and for any project would be $25 million. By structuring the policy with optionality, it will serve to meet the needs of market actors who have different policy tools at their disposal. The optionality complements existing and (potential) future provincial/utility renewable gas funding. It will send a strong signal to

[10] Loans are to be provided to SME's. Repayment of those loans will only be triggered once the SME's technology has reached commercialization and profitability (measured via a negotiated EBITA). The Fund will also seek repayment second to senior secured debt.
[11] See Appendix 3 for a listing of existing CSA standards for renewable gases.
[12] Eligible costs will follow existing federal Contribution Agreements.
[13] Further reconciliation is required on how a 5-year production incentive is managed under a fund with only 6 years. The fund could 'close' to applicants in year 3 but retain a stand-alone funding arm until the expiration of the production incentive terms.

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the market that will enable improved access to private third party capital. Federal contributions would be repayable upon project profitability. To determine profitability, a specific formula will have to be developed.

The Fund would be open to renewable gas project developers including municipalities, Indigenous communities, forestry or agricultural operators, utilities or third party project developers of renewable natural gas and renewable/green hydrogen projects. The program would focus on near term production opportunities that can demonstrate technical feasibility, fiscal stability and that have a broad set of committed stakeholder partners. Each project would have the stated goal of injecting their renewable gases into the Canadian natural gas pipeline system. Exceptions would include projects where the renewable gas is used as a transportation fuel (LNG or CNG) or for a remote end user seeking to benefit from the use of a renewable gas (remote power generation or a dedicated/distributed natural gas grid). Specific criteria would be included in the fund requiring that each renewable gas project ensure the volumes of renewable gases remain in Canada for Canadian use. At present, some of Canada's RNG producers are selling their RNG supply into the California marketplace taking advantage of United States federal and state level subsidies.

Finally, the commercialization Fund would support important renewable gas training/education activities, project feasibility studies and front end engineering and design (FEED) work. Each are detailed below at a high level. Specific funding envelopes for these activities are not yet determined.

Education: the focus will be placed on supporting the development of materials and education courses by technical institutes (e.g., provincial/territorial Institutes of Technology or industry associations such as the Canadian Biogas Association). These courses would be made available to the market to better train renewable gas project owners/operators (e.g., to optimize their facility or fix/install new components). Existing plant operators in jurisdictions where renewable natural gas is more developed highlight the gap between manufacturer support and the inherent challenges in operating a plant on a daily basis. To this end, renewable gas plant operators require technical training courses to better manage their digesters, gas upgraders, etc. Federal funding for renewable gas education could support the development of technical training courses on renewable gas production, operation and compliance with codes and standards. These guidelines and courses would then be made available to engineers, feedstock owners and existing renewable gas plant operators.

Feasibility studies: feasibility studies are an important early project screening tool. They support preliminary viability, profitability and technical risk[14]. The Fund would make available up to $30,000 for a feasibility study if matched 50% by the project proponent. Each study would have to be first approved by a renewable gas selection committee[15] to ensure the project met the program criteria/objectives. The goal of the feasibility study is to support and advance more detailed front end engineering and design (FEED) work.

FEED studies: A second early action support Fund would be made available for FEED studies. Unlike feasibility studies, there would be no financial limit on the total value of a FEED study, given the variability in renewable gas project size and complexity. However, again, there

[14] Feedstock characterization, distance from pipeline, technology options, initial payback, etc.
[15] The Committee would include government, industry (broad suite of interests to be represented) and renewable gas market/technology experts.

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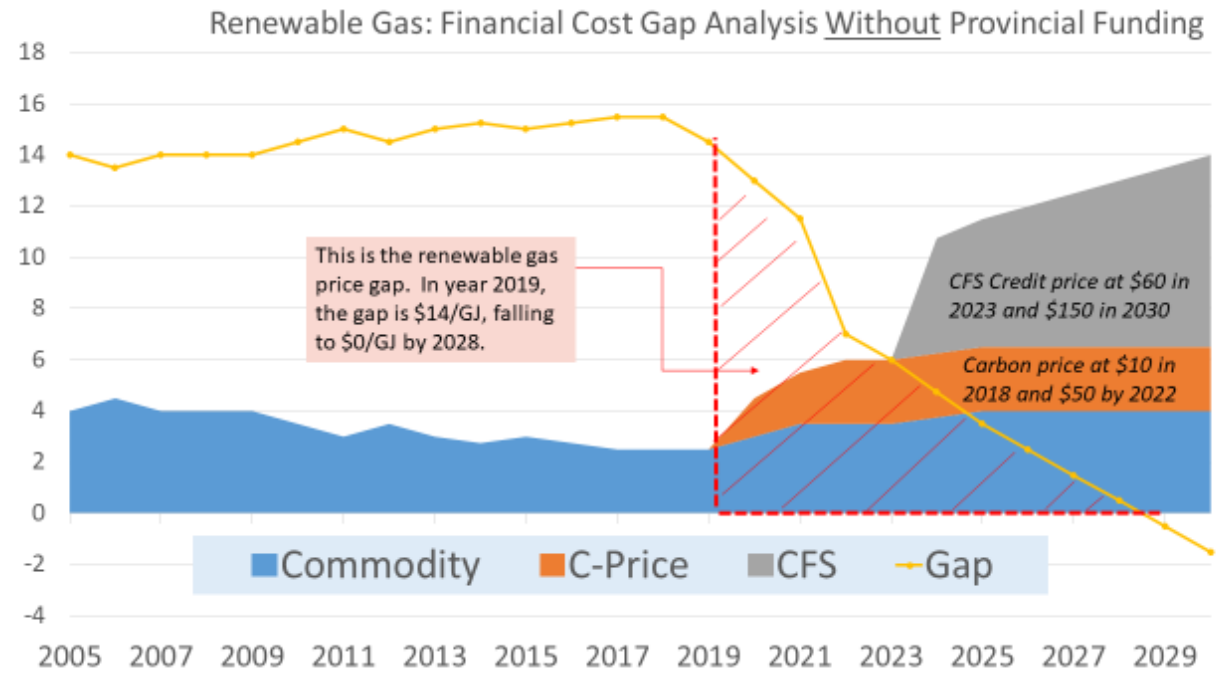
would remain a 50% matching requirement.

Policy Rational - Renewable Gas Funding

For context, a 5% renewable blend rate in the natural gas pipeline system is equal to 184 Petajoules (PJ) of renewable content based on 2017 natural gas use in Canada. For comparison, 184 PJ's of energy is equivalent to the natural gas use from 1.7 million Canadian homes for a year.

The graphic below is presented from the renewable gas project developer's perspective. The graphic shows a forecast commodity cost of natural gas[16] (blue), the renewable gas cost gap (yellow line) and the impact of future federal policies (orange and gray). It is important to note that the cost gap does not include any provincial utility funding that is or may be made available in the future for renewable gases. For example, today in BC, FortisBC is permitted to offer an RNG producer up to $30/GJ and in turn recover the difference between the market price for natural gas and the RNG price from a combination of its voluntary RNG subscribers and the broader rate base of 1 million consumers in BC. In Quebec, the largest gas utility, Énergir, is seeking the ability to support project developers with an incentive in the low $20/GJ range. In these provincial cases, a project with a cost gap of $17/GJ would be fully covered by the provincial program. However, federal funding, by way of a capital cost contribution, would allow the proponent to secure project financing from the federal government which in turn lowers their 'ask' of the provincial utility (i.e., the utility can offer a lower production feed in tariff to the renewable gas proponent). The result of this is that the utility will be able to extend the reach of their approved funding and bring online more projects than they would have without federal funding.

As shown in the graphic, absent carbon pricing or other policies (years 2005 to 2018), the average differential between commodity fossil gas and renewable gases remains at between $10-13/GJ. The cost gap narrows with new federal policies including the $20/tonne carbon price in 2019 rising to $50/tonne by 2030 (shown in orange) and the federal CFS beginning in 2022 at $50/tonne rising to $150 in 2030 (shown in gray). Also included in the analysis (but not shown) is a decline in cost of producing renewable gases. We assume a decline in production costs from an average of approximately $17/GJ in 2018 to approximately $13/GJ in 2030. The combination of all of these factors means that for a project developer, there is no positive cash flow until 2028 to 2030.



[16] NEB Energy Futures Report – 2017.

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Natural Gas - The Canadian Context to 2040

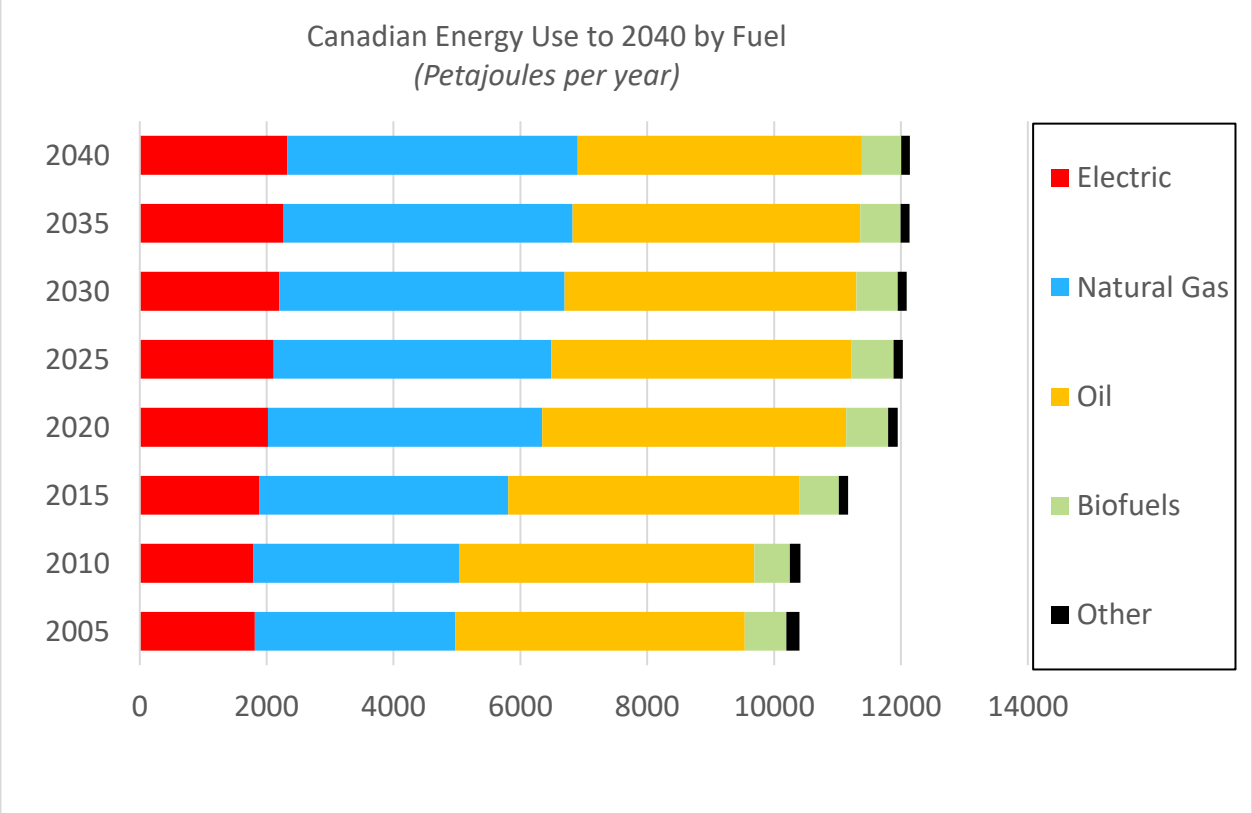
In 2017, natural gas provided 34% of Canada's energy needs. Natural gas is delivered to over 20 million Canadians every day through 500,000 kilometers of infrastructure. Nationally, natural gas is the single largest fuel source for buildings and industrial facilities in Canada.

Over the last decade, natural gas utilities have added over 1 million new customers (buildings, industrial plants and power generation facilities). As a result, natural gas use has increased 28% in Canada. The increased use is principally in response to a sustained low price environment and new power generation policy measures. Across multiple sectors gas use is increasing including:

- in the power generation sector where gas is acting as a replacement for coal fired generation.
- in new communities – in both rural and remote regions of the country – where constituents are seeking natural gas service to move away from high priced and higher emitting energy sources.
- in high freight transportation sectors including on road trucking and marine vessels.

Looking to 2040, the National Energy Board (NEB) forecasts that natural gas will become the single largest fuel source for Canadians, surpassing petroleum products for the first time. Shown below is data from the NEB's Energy Futures Report[17] that forecasts natural gas will realize an annual growth rate of 0.6% per year (or a 16% growth between 2015 and 2040). During the same period, natural gas use is forecast to grow by 650 petajoues (PJ) followed by electricity at 440 PJ. Oil use is expected to decline 103 PJ and biofuels declines 6 PJ and other fuels by 15 PJ.

In addition to energy end use, the NEB forecasts delivered prices for energy to the year 2040. The forecast for delivered residential energy prices to 2040 shows natural gas 200-300% more affordable than oil and electricity. The affordability of natural gas means that substituting it for other energy options will improve energy affordability and Canadian competitiveness.



[17] https://www.neb-one.gc.ca/nrg/ntgrtd/ftr/2017/index-eng.html

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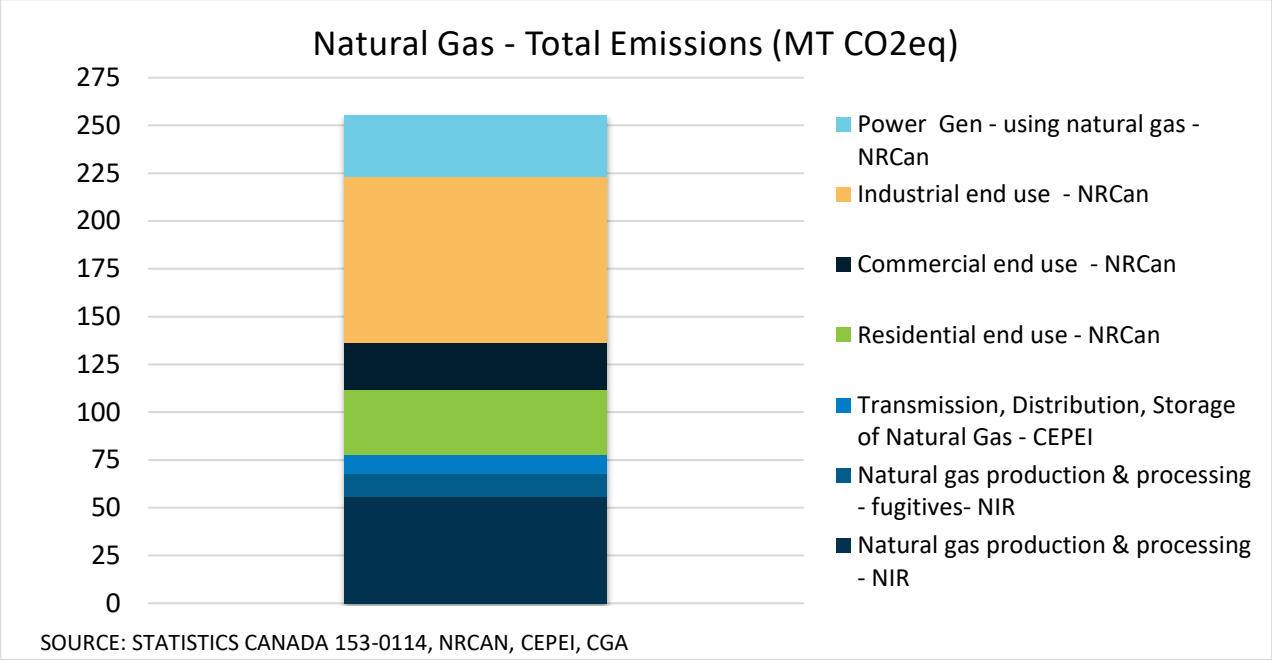
Natural Gas GHG Emissions and Renewable Gas GHG's - The Canadian Context

Canada's total GHG emissions are reported at 704 Megatonnes (MT) CO_{2e}. Natural gas accounts for approximately a third of this value at 255 MT CO_{2e}. As illustrated, approximately one third of the natural gas life cycle emissions are from its production whereas the remaining are from its combustion. Natural gas emissions have increased over the last decade but at a declining average annual rate as consumers take advantage of utility energy efficiency programs, respond to equipment regulations and building codes and deploy new technologies. Further, the greater use of natural gas, the lowest emitting fossil fuel, in place of heating oil, diesel or propane serves to reduce GHG emissions across the Canadian economy.



SOURCE: STATISTICS CANADA 153-0114, NRCAN, CEPEI, CGA

In 2016, CGA commissioned ICF International to develop data and information on RNG GHG emissions reduction opportunities by province. ICF analysis shows that a (approx.) 5% substitution of Canada's gas demand with RNG would reduce GHG emissions by 14 MT. The 14 MT includes both displacement of fossil gas and the captured methane that would otherwise be vented from various sources. The data from that study is shown below along with provincial natural gas GHG emissions.

Provincial Emissions and GHG Reduction Potential			
Province	**Natural Gas End Use GHG Emissions (Megatonnes)**	**Annual GHG Emission Reductions from RNG (Megatonnes)**	**Number of Passenger Cars Equivelant**
BC	11	0.7	147,000
AB	61	4.3	903,000
SK	7	0.6	126,000
MB	4	0.2	38,219
ON	41	8.0	1,680,000
QC	12	0.5	105,000
NB	0.2	0.1	21,270
NS	0.3	0.1	21,000
Total	**136**	**14**	**3,041,489**
Source: ICF International, Statistics Canada, CGA RNG Data			

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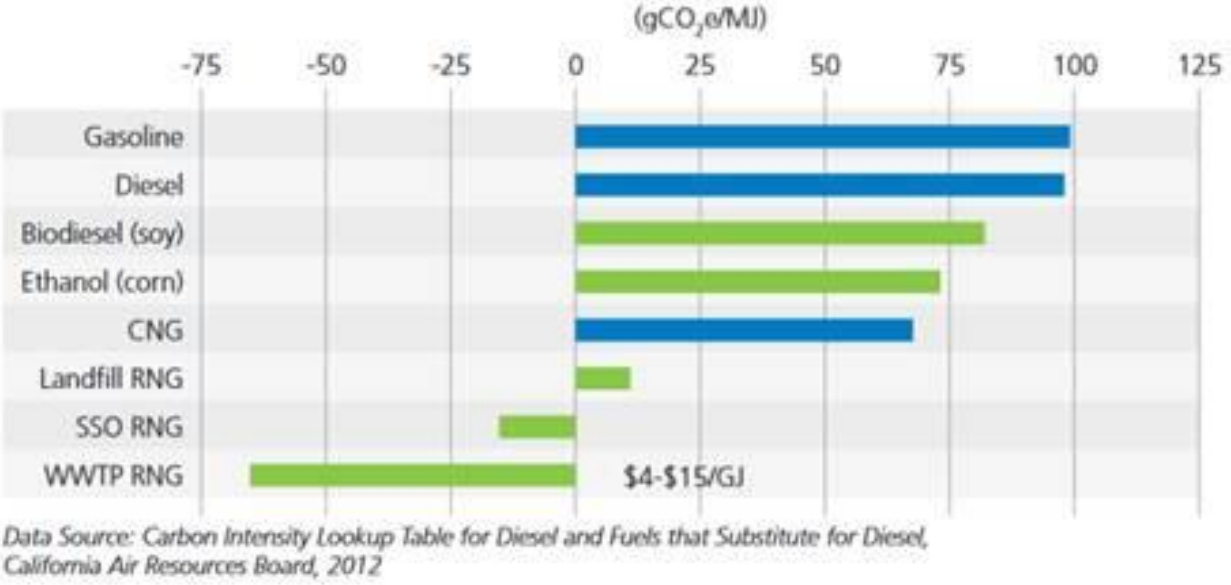
Going forward, there is an identified need in Canada to develop lifecycle GHG figures for a range of renewable gas sources, by province. CGA has proposed this research federally. There has been extensive work on this issue in California and in recent RNG lifecycle work in British Columbia. The image below is from the California Air Resource Board. Of note is the significant negative GHG emissions from waste water treatment plans and source separated organics. Canadian results will look similar. Therefore, it is important for Canada to more fully understand the renewable gas lifecycle potential for the country. Also of note is the fact that neither hydrogen nor synthetic methane are shown below (and the RNG cost band from $4-$15 for wastewater would be low for Canada).

California Air Resources Board – Lifecycle GHG Impacts of Fuels



Data Source: Carbon Intensity Lookup Table for Diesel and Fuels that Substitute for Diesel, California Air Resources Board, 2012

Renewable Gases - Benefits to Canada

Canada has a significant and untapped renewable gas opportunity. As indicated in a 2010 report[18], RNG from wastes alone could account for 130% of Canada's residential natural gas demand. At present, only 11 projects are producing RNG in Canada and with one active power-to-gas hydrogen project. That project, in Markham, Ontario[19] is not currently injecting into the grid but producing hydrogen for sale in transport markets. The intention is to connect the supply to the pipeline system in the future. With Canada's wealth of forests, agricultural wastes, and our extensive interprovincial and local distribution natural gas pipeline network, we are well positioned to be world leaders in this area from feedstock supply to connecting supply to market.

In addition to our significant renewable gas resources, Canada is home to two of the world's leading renewable gas companies - Xebec and Hydrogenics[20] - and a number of other innovative companies supporting renewable gases (G4 Insights, Greenlane biogas, Ballard, etc.). It is both the emerging and established companies in Canada that require further deployment and commercialization support to provide the globe with the renewable gas solutions they demand. Natural gas utilities bring the ability to leverage their extensive customer base, patient capital, and stable regulated approach to deploy innovation.

[18] The Potential for Producing Renewable Natural Gas from Canadian Wastes – Dr. Salim Abboud, Alberta Research Council, 2010.

[19] https://www.newswire.ca/news-releases/hydrogen-news-north-americas-first-major-power-to-gas-energy-storage-facility-now-open-688296451.html

[20] In 2017, Xebec and Hydrogenics were selected by Export Development Canada as Canadian Cleantech Export Stars. Xebec manufactures RNG cleanup technologies and Hydrogenics develops power-to-gas technology.

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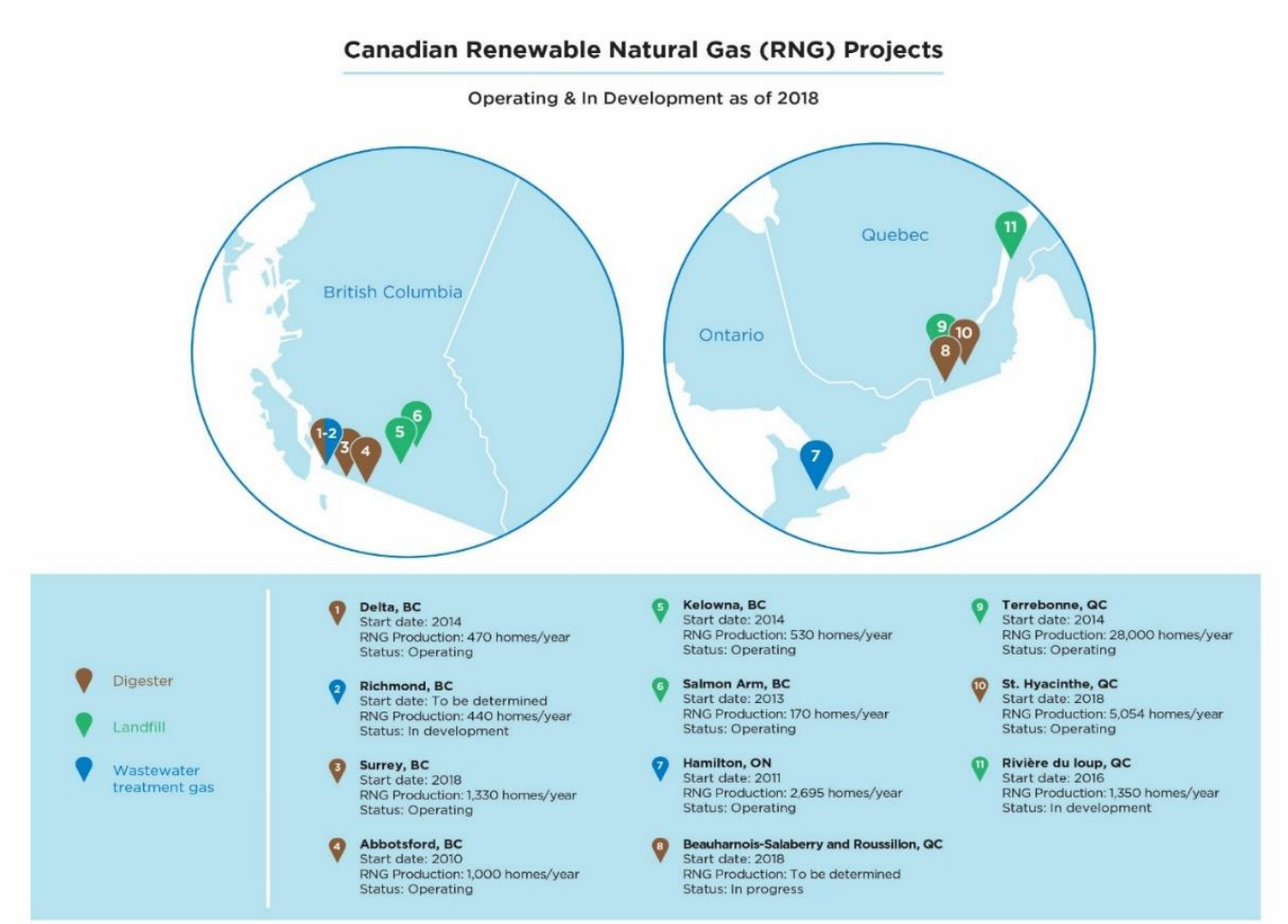
Renewable Gases - Provincial Policy Support

To date, provincial policy support for renewable gases has largely been focused on renewable natural gas. Emerging support for hydrogen is materializing as a means to store intermittent renewable electricity. Much of the synthetic methane activity is focused in biomass conversion to RNG or in the areas of solar fuels – using hydrogen from power to gas and converting it to synthetic methane with carbon dioxide and a catalyst. Three provinces have to date taken a leadership role in renewable gases: British Columbia and Quebec on RNG and Ontario on hydrogen. The map[21] shows the existing RNG and hydrogen power to gas projects in Canada. In total there are 12 RNG projects currently operating, a number of announced projects, and 1 hydrogen power to gas project.



In BC, the local utility FortisBC was the first gas utility in North America to offer a voluntary RNG program, in the year 2010. The program, as of spring 2018, has saved over 30,000 tonnes of GHG's in the province. FortisBC natural gas customers can choose to blend from 5 to 100% RNG into their gas mixture and pay a portion[22] of the corresponding premium for that product. Fortis has approximately 10,000 customers on their program, including large users of natural gas such as the City of Vancouver, University of British Columbia and others. There are currently five operating RNG projects in BC with two in construction and others in the development process. The most recent project in BC, located in Surrey, was a recipient of federal P3 funding.

[21] CGA is currently updating the map and will have a new version with all announced projects, and new project timelines by end September 2018. Two notable changes are: the start date for project #8 is 2021, and project #11 is 2018.
[22] A recent British Columbia Utility Commission (BCUC) decision allows the incremental RNG cost in BC to be shared between the voluntary customer and the rest of the 1.1 million FortisBC natural gas customers.

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In Quebec, various RNG project developers have partnered with federal and provincial funding agencies (including the Federation of Canadian Municipalities Green Municipal Fund) to advance RNG projects. The largest gas utility in the province, Énergir, is anticipating a directive from the Quebec government that would see a 5% blend mandate in the 2025 to 2030 timeframe. There are currently three RNG facilities operating in the province with many others in the development process.

In Ontario, the two large gas utilities, Union Gas and Enbridge Gas Distribution, have been actively working on renewable gases since 2010. Efforts have included an application to the Ontario Energy Board for approval to advance RNG in Ontario and more recently a RNG funding proposal and a province wide RFP for RNG supply contracts. Today, Ontario is without a renewable gas policy framework. Despite this, there are three operating/announced RNG facilities in Ontario in Hamilton, Toronto and Havelock.

In Alberta, a small RNG deployment project is set for commencement in Q2 2018 that will see biomass converted to RNG via the G4 Insights Technology (Vancouver based) and injected into the ATCO Gas pipeline system. At this time however, Alberta is without a distinct renewable gas policy. In Nova Scotia, there has been activity with one large municipality that is looking at RNG at their landfill and other smaller farm based systems. In Canada's other provinces and territories, renewable gases are at varying stages but in all cases the policy discussions, where they are occurring, have only began in recent months.

Across Canada, there is an increasing number of stakeholders conducting RNG research and development. For example, researchers out of the University of Waterloo are working on advanced techniques to convert cow manure to methane[23]. At CanmetENERGY in Ottawa, researchers have been active in renewable gas R&D for over a decade including anaerobic and gasification research. Similarly, the National Research Council has also been conducting work in the area of RNG including co-digestion techniques, among others. On Canada's west coast, the University of British Columbia's Clean Energy Research Centre has been working on RNG (and other renewable gases) and FP Innovations has recently began to engage in RNG research needs for its member companies in BC.

Regarding hydrogen, the first power-to-gas (P2G) hydrogen project is in commercial operation in Markham, Ontario. The project in the first phase is not connected to the pipeline system but is providing electricity storage and regeneration functions. Phase 2 of the project proposes to blend and connect the hydrogen to the Enbridge Gas Distribution system. The role of hydrogen production via P2G is being explored by other provinces and is being driven by a host of factors but principally by the need for large scale storage to balance electricity supply and demand as a result of new intermittent renewable electricity supplies. P2G is one of the many electricity storage options but the only one that fully integrates the natural gas pipeline with the electricity grid and generation assets.

Finally, synthetic methane, while being deployed by to convert biomass to RNG by G4 Insights, a Canadian company out of Vancouver, is generally at an earlier stage of development in Canada. There is some R&D activity in Canada at the University of Toronto's Solar Fuels Cluster)[24].

Renewable Gases ‑Paris 2030 Targets and the Federal Mid-Century Strategy

Renewable gases offer a number of benefits to help achieve Canada's Paris 2030 GHG targets. A 5% renewable gas blend can reduce GHG emissions by 14 MT. Also, renewable gases offer a long term solution for reducing emissions from freight transportation, space and water heating and industrial process heat. There is at present no readily available alternative energy technology that can accomplish this at a reasonable capital or operating cost. Over the longer term out to 2050, natural gas infrastructure as an energy carrier will continue to be a critical component of a low emission energy system. Natural gas infrastructure in Canada is a multi-billion dollar asset that provides reliable, safe, affordable and high-

[23] https://www.cbc.ca/news/canada/kitchener-waterloo/university-waterloo-farm-manure-energy-1.4568992
[24] http://www.solarfuels.utoronto.ca/

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quality energy services to Canadians. This infrastructure is designed to meet peak winter gas delivery volumes for heating needs and gas power plant requirements while at the same time providing the steady state service to industrial clients who operate 24/7. Natural gas infrastructure can carry renewable energy sources in much the same way (but in molecular form) as electric infrastructure. Further, gas infrastructure is ready-made for energy storage with 850 billion cubic feet of in=-place storage in Canada, equal to 90 days of national gas demand or the energy needs of 11 million homes for one year.

A number of research efforts around the world are shifting their focus to the role of gas and gas infrastructure to achieve the long-term emission reduction objectives of the Paris Agreement and beyond. A number of scenarios are emerging which suggest that future global energy systems will maintain a foundational role for gaseous pipeline infrastructure that is increasingly delivering lower emission or renewable content. The benefits of gaseous infrastructure are many, including:

- a parallel system to the electricity grid that can carry renewable energy sources to consumers across a range of end uses combined with a fuel source (natural gas) that is low cost and in high demand from consumers around the world;

- a pipeline and storage network that can support intermittent renewable electricity sources by deploying hydrogen power-to-gas technologies that allow electricity to be converted to hydrogen and stored in the natural gas system;

- improved feasibility of reducing the emissions of heat generation by moderating the need for building retrofits, maintaining consumer preference for gas, and limiting the need for technology breakthroughs for high-temperature heating for industrial consumers, and;

- improved energy resiliency (to weather and cyber threats), via the continued availability of both a natural gas system (which is underground) and an electricity system.

Renewable Gas – Future Proofing

The cost premium of renewable gases means they cannot compete with incumbent fossil gas supplies. Over the first half of 2018, natural gas prices averaged $3/GJ at the major trading hub in the United States. This compares to a much higher and wider range for renewable gases at $10-30/GJ. However, in the same way that more expensive wind power generation was not, in its early development, compared to cheaper coal fired power generation, renewable gases should not be compared on a cost basis to the incumbent non-renewable natural gas. Rather, it should be compared to other renewable energy options (like wind or solar) on a delivered basis to the consumer with the costs of storage included. When this analysis is carried out, renewables gases are cost competitive with existing provincial electricity supplies. Looking forward, the expected increase in electricity costs combined with the expected decline in renewable gas costs offers a compelling rational for federal support. A sustained program to support renewable gases that recognizes both their deployment and their technology de-risking will serve to bring down the costs of production and commercial viability.

The status of renewable gases today can be compared to nascent solar markets in the early 2000s in that it is emerging, requires R&D on next generation solutions, and needs commercialization funding to generate manufacturing scale that will drive down equipment and permitting costs. One of the principal goals of this program would be to set the stage for the long-term declines in the cost of renewable gas supplies. It should be noted as well that renewable gases are different from biofuels in that there is no specific technology or feedstock winner in the way that agricultural ethanol benefits as a blended fuel for gasoline. RNG, for example, has many different feedstocks (many from waste streams) and various project proponents/stakeholders – thus creating real competition for supply. The program would aim to crystallize a renewable gas sector including the consultants, developers, service providers, and the like that are needed to support the growth of the industry and support those sectors to expand renewable gases via multiple different feedstock streams.

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Renewable Gas Challenges - Need for Policy Support

The Federal Government has historically provided program support for renewable electricity technologies (wind, solar, biomass), carbon capture and sequestration (CCS) and biofuel production (ethanol and biodiesel). For example, in 2007, the federal ecoENERGY for Biofuels Program provided an investment of up to $1.5 billion over nine years to encourage greater production of biofuels and accelerate the commercialization of new biofuel technologies. Additionally, the federal ecoENERGY for Renewable Power Program was established in the same year to encourage the production of electricity generation from low-impact sources like wind, small-hydro, biomass, photovoltaic and geothermal energy. As of March 31, 2011, $1.4 billion had been invested on over 100 projects to increase Canada's production of domestic renewable energy. In total, almost $3.5 billion of market stimulus has been provided to support renewable energy growth in the biofuel, renewable electricity and CCS sectors over the last decade. More recently, Budget 2016 introduced three new programs all in support of renewable electricity and/or biomass (remote diesel fund, emerging renewable electricity program and smart grid program).

To date, Canada has not had a dedicated federal program to support or stimulate renewable gases in Canada's largest energy end-use sector - the natural gas sector. Given the proposed federal Clean Fuel Standard under development by Environment and Climate Change Canada (ECCC) and the untapped GHG reduction potential of renewable gases to support Paris 2030 GHG targets, this proposal is the first step in designing a modern supply side support program for renewable gases in Canada. Current funding envelopes such as the Low Carbon Economy Fund, while open to project like renewable gases, are largely ineffective in supporting market transformation activity. A dedicated fund is what is required to make clear to lenders and the market the importance of renewable gases.

Federal Fiscal Options for Renewable Gases

In Canada, Federal public sector support for renewable energy has taken many forms including accelerated capital cost allowances, direct program support, technology funding, production incentives and repayable loans.

For renewable gases, as noted early in this proposal, a flexible set of fiscal options is what is needed to meet the variability in needs from the market. Some provinces are further along than others and the needs of project proponents will be different depending on the circumstances in that province or territory. As noted, the options include a production incentive, a capital cost contribution, and a hybrid of the two options. Further analysis is needed to determine if a modern federal fiscal program can be structured to effectively manage the wide cross section of need.

An important first step would be a national competitive RFP process to solicit project opportunities. This process would provide important data (locations, size, cost/funding need, etc). The information solicitation process can leverage already commissioned market information collected by gas utilities in advance of their renewable gas program launches.

With respect to tax policy, there are measures that can be supportive such as investment tax credits. However, these measures are only suitable for entities with existing cash flow and revenues and are not an effective option for early stage project developers or first time project proponents. Accelerated capital cost allowance (ACCA) is another measure but is only of benefit to existing corporations seeking to defer tax payments into a future year. Further, many renewable energy projects already receive ACCA, a measure re-affirmed in Budget 2018.

Ultimately, a more detailed federal government assessment of the proposed fiscal support measures should be carried out. Federally, there is extensive in-place experience in designing renewable energy programs. Industry remains committed to supporting this effort.

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Next Steps

CGA has made a federal pre-budget submission (August 3, 2018) that has included a renewable gas funding request of $750 million. Over the course of the summer/fall 2018, the industry will continue to consult with and incorporate the perspectives of government officials, natural gas value chain companies, natural gas consumers, the renewable gas industry (technology providers, vendors), feedstock suppliers (municipalities, forestry companies, and agricultural companies), and environmental non-governmental organizations in the fine-tuning of this proposal. Further, CGA will meet with and brief Parliamentarians on the proposal and advance a social media information effort on renewable gases starting in September 2018.

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Appendix 1.
Global Renewable Gas Policies and North American Hydrogen Blending Summary

RNG	Country	Year	Link to details.	Details
	Italy	2018	http://europa.eu/rapid/press-release_IP-18-1441_en.htm	Support RNG and biofuels. Program runs from 2012 to 2022. Funded by refinery/oil companies under a transportation directive aimed at seeing 10% of fuel come from renewable sources.
	France	2018	French natural gas operators' forecast http://www.snam.it/en/Media/energy-morning/20171122_2.html	Goal of 30% of France's gas needs with renewable gas by 2030.
	Germany	2014	2014 Amendment of the Renewable Energy Sources Act (EEG 2014) https://www.iea.org/policiesandmeasures/pams/germany/name-145053-en.php	Provides a framework so that energy produced from renewable energy sources is guaranteed priority for feed in to the public grid. Payments are made within a 20-year fixed FIT. Operators of the transmission system recoup system costs through a surcharge to consumers. RNG producers are guaranteed that their energy will be fed into the pipeline.
	Finland	2014	Excise Tax Exemption https://globalmethane.org/documents/news-item-438/08-Finland.pdf	In Finland, biomethane is exempted from production and excise taxes.
	United Kingdom	2014, updated 2018	Renewable Heat Incentive (RHI) https://www.ofgem.gov.uk/environmental-programmes/non-domestic-rhi/contacts-guidance-and-resources/tariffs-and-payments-non-domestic-rhi	From May 22, 2018 onwards, anaerobic digestion (AD) plant operators will be able to claim a restored tariff of 5.6p per kWh of renewable heat generated for their Tier 1 biomethane (the first 40,000 MWh they inject into the grid per year), and once their plant is commissioned, they will receive a guaranteed tariff level for 20 years.
	USA	2005	Renewable fuel standard (RFS) - Renewable identification numbers (RINs) https://www.epa.gov/renewable-fuel-standard-	Congress created the renewable fuel standard (RFS) program to reduce greenhouse gas emissions and expand the nation's renewable fuels sector while reducing reliance on imported oil. Renewable identification numbers (RINs) are credits used for compliance (certain volumes of gasoline or diesel

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			program/overview-renewable-fuel-standard	fuel must be "green"), and are the "currency" of the RFS program. Percent of renewable fuel by volume required in 2018: Advanced Biofuel - 11.0% Total Renewable Fuel: 26.0% Conventional Biofuel: 15.0%
Hydrogen	France	2017	https://www.reuters.com/article/us-engie-biogas/engie-plans-to-go-green-via-biogas-and-renewable-hydrogen-idUSKBN1DY22D http://en.rfi.fr/20180601-france-invest-millions-hydrogen-energy-production/	To achieve carbon neutrality by 2050, French utility Engie plans to switch all of its gas operations to RNG and renewable hydrogen by 2050, making it 100 percent green, its chief executive states. To develop hydrogen for use in industry and transport, Environment Minister Nicolas Hulot pledged to invest 100 million euros in 2019.

Country Details

Italy: In March 2018, the Italian Government recently identified the transportation sector as a primary end user for renewable natural gas (RNG) in the form of bio-CNG and bio-LNG. The European Commission under EU State aid rules approved an Italian support scheme for the production and distribution of advanced biofuels, including advanced biomethane. Italy's Economic Development Ministry (MISE) then signed two new energy decrees which include measures to aid large gas consumers as well as incentives for biomethane in transport for Euro 4.7 billion (CDN$7.4 billion). Within two weeks, Italy's Gas Operator, Snam, had received more than 500 requests from potential biomethane producers to connect their upcoming biomethane production sites to the existing gas grid, indicating a market size for biogas upgrading equipment in excess of CDN$ 1.5 billion over the next 3 to 5 years.

Germany: The Renewable Energy Act, last amended in 2014, provides a framework so that energy produced from renewable energy sources is guaranteed priority for feed in to the public grid. Payments are made within a 20-year fixed FIT. Operators of the transmission system recoup system costs through a surcharge to consumers. Per this act, energy producers using AD systems are guaranteed that their energy will be fed into the grid. Incentives of this kind reduce the financial risk incurred by the owner of the AD system.

France: By 2030 it will be possible to meet 30% of France's gas demand through gas of renewable origin. Based on the outlooks, gas in France will be increasingly used for transportation, whereby a number of vehicles powered with methane will go up from the present 15,000 300,000 by 2035. In the most promising evolution scenario in turn, CNG vehicles will reach 1 million and in 2035 they will account for 10% of the French gas demand. Finally, it is predicted that gas consumption for electricity generation will remain steady at around 40 TWh a year (70 TWh/year also considering co-generation) until 2025.

UK: The Renewable Heat Incentive is composed of two parts: domestic RHIs are available to homeowners, landlords, social landlords and self-builders; and non-domestic RHIs are available to industry, public sector organizations and businesses. RHI program participants are compensated for generating and using renewable energy sources to heat buildings. Under the domestic RHI program, tariffs are paid per every kilowatt-hour of heat generated and price varies by technology. RNG receives policy support and details are available here:

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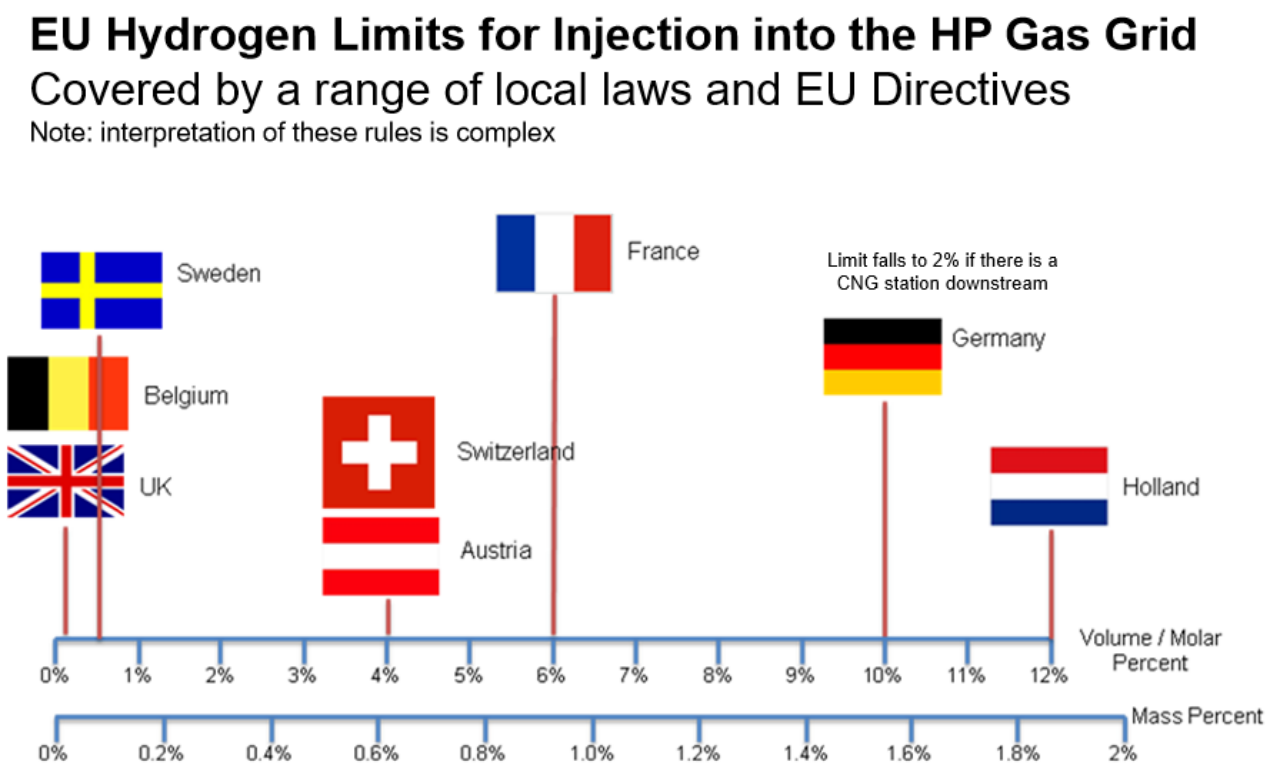
https://www.ofgem.gov.uk/system/files/docs/2018/07/fit_generation_and_export_payment_rate_table_01_july_-_31_march_2019.pdf.

USA: Congress created the renewable fuel standard (RFS) program to reduce greenhouse gas emissions and expand the nation's renewable fuels sector while reducing reliance on imported oil. This program was authorized under the Energy Policy Act of 2005 and expanded under the Energy Independence and Security Act of 2007. The RFS program requires a certain volume of renewable fuel to replace or reduce the quantity of petroleum-based transportation fuel, heating oil or jet fuel. Renewable identification numbers (RINs) are credits used for compliance (certain volumes of gasoline or diesel fuel must be "green"), and are the "currency" of the RFS program. Renewable fuel producers generate RINs, market participants trade RINs, and obligated parties (refiners and importers of gasoline or diesel) obtain and then ultimately retire RINs for compliance. RNG has played a significant role in the US RIN market. According to the RNG Coalition, the RNG industry current producers more than 95 percent of the fuel that is used to meet the RFS program's cellulosic RVOs, with production of RNG increasing from 33 million gallons in 2014 to more than 240 million gallons in 2017. The industry has developed more than 45 new facilities capable of producing cellulosic biofuel since 2011, with an additional 50 projects currently under construction or development.

France (Hydrogen): France Climate Plan, initiated in July 2017 by Nicolas Hulot, France's Minister of the Ecological and Inclusive Transition, re-affirmed the proactive strategy for the energy transition with ambitious objectives, such as achieving carbon neutrality by 2050. Dec 4, 2017 - French utility Engie plans to switch all of its gas operations to biogas and renewable hydrogen by 2050, making it 100 percent green, its chief executive said on Monday. By 2050, hydrogen could account for 20% of France's energy demand, power 18% of vehicles and cut carbon emissions by 55 million metric tons—almost a third of the reduction required under the +2°C reference scenario. France has launched an ambitious plan to develop hydrogen for use in industry and transport, with Environment Minister Nicolas Hulot pledging to invest 100 million euros in 2019 to get the gaseous ball rolling.



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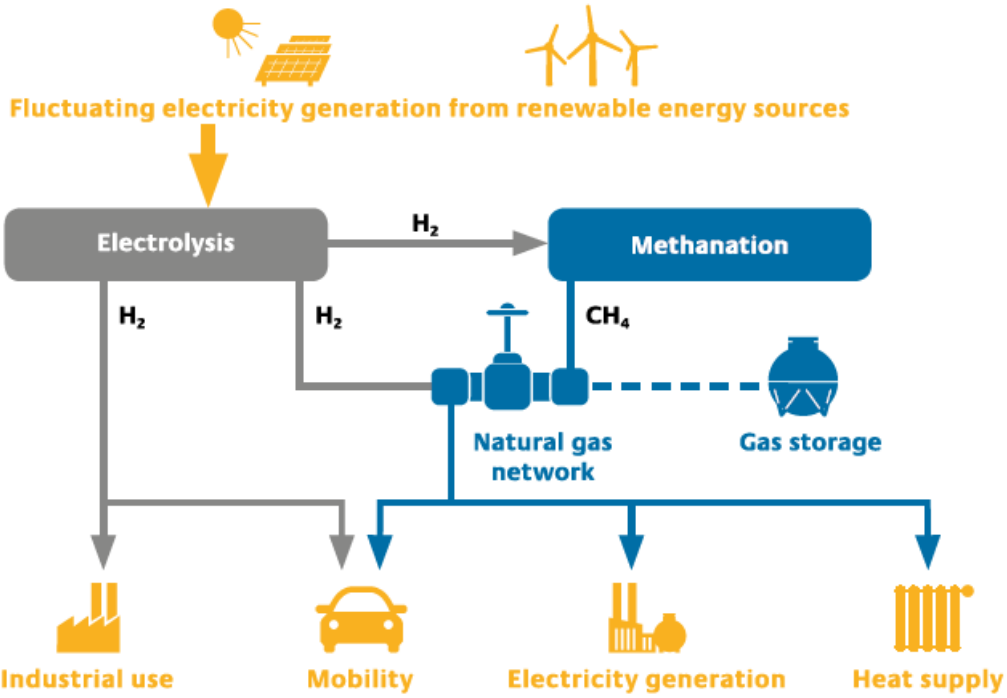
Appendix 2.
Hydrogen Power to Gas

A successful transition towards a lower emission energy system will be benefitted by the large-scale implementation of renewable energy sources. Some of these, such as wind and solar, can be distinguished from conventional fossil-based energy sources by their low life-cycle GHG emissions but also by their intermittent character. By introducing intermittent energy sources, the need for overall stability of energy systems increases strongly, requiring consideration of alternate solutions to provide that required system stability. One potential solution is Power-to-Gas.

Power-to-gas is the common description of the transformation of electrical energy into chemical energy in the form of hydrogen. The process typically involves electrolysis, potentially powered by renewable energy sources, to 'split' water molecules (H_2O) to produce hydrogen (H_2) and oxygen (O). The hydrogen produced can be stored for later use or it can be blended into existing natural gas infrastructure for immediate utilization. It is also possible to transform an even greater volume of renewable electricity in a gaseous state in a second step via the use of a catalyst to combine hydrogen with carbon dioxide to produce synthetic methane which can also then be blended into natural gas streams.



In 2017, the American Gas Association and the Canadian Gas Association formed a Task Group to study power-to-gas to understand the technical considerations of blending hydrogen into the existing natural gas infrastructure, currently feeding energy to well over 80 million residences, businesses, institutions & industries in the United States & Canada.

The Task Group produced an Information Summary Report (ISR), based on an open source literature search, to establish of a broader base of understanding of power-to-gas by introducing the reader to overall considerations by system segment and percentage blending options. The ISR report provides CGA and AGA member organizations with a synopsis of existing information to assist the natural gas delivery industry in identifying due diligence activities related to the possible introduction of hydrogen. A comparison of the main properties of hydrogen versus methane (as the principal constituent of natural gas):

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Item	Methane	Hydrogen
Chemical Formula	CH_4	H_2
Molecular Size[1]	416 pm (isotropic molecule)	340 pm / 304 pm (anisotropic molecule)
Specific Gravity[2]	0.5548	0.0695
Higher Calorific Value (HHV)[2]	37.7 MJ/m^3 1,013 BTU/ft^3	12.1 MJ/m^3 325 BTU/ft^3
Wobbe Number (WN)[2]	50.6 MJ/m^3 1,359 BTU/ft^3	45.9 MJ/m^3 1,231 BTU/ft^3
Products of Combustion	Carbon Dioxide (CO_2) Water Vapour (H_2O)	Water Vapour (H_2O)

All properties given at standard conditions for temperature and pressure (15.6°C and 101.4 kPa or 60°F and 14.7 psi)

1 Molecular size based on the Van der Walls radius of the molecule

2 Value of properties calculated in accordance to standard ISO 6976with NGTC's Interchangeability Calculator.

A main conclusion included in the ISR was that, due to the complexity of natural gas delivery systems, and the wide variety of the in-place components, materials and equipment, it is not possible to specify one limiting hydrogen value which would be valid for all parts of natural gas infrastructure. It should also be noted that there is no one international standard for the percentage blending rate of hydrogen into natural gas delivery systems.

The ISR does discuss the blending of hydrogen into natural streams in ranges from 0 % to 5 %, understanding that specific percentages would depend on each organization involved in the delivery of natural gas fully investigating & understanding critical pipeline system components, i.e. each specific delivery system must be looked at in the context of the materials it is made up of and the end-users and equipment that it serves. The Task Group also noted that further study and investigation of the benefits and impacts of hydrogen blending into natural gas streams should be considered.

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Appendix 3.
Renewable Gas Codes and Standards

Provided below is a listing of standards developed for renewable gases. In some cases, these may require updating, or new standards all together, depending on the renewable gas blend rates. Consideration will need to be given to pipelines where hydrogen injection rates go beyond current pipeline tariff specifications and the corresponding downstream impact on gas appliances, natural gas vehicle CNG tanks and turbines. Finally, there is a need for additional research and exploratory work in the area of hydrogen blending on various steels.

- CSA FC 5 *Hydrogen generators using fuel processing technologies* (U.S. adoption of ISO 16110) - *Not yet published.*
- CSA/ANSI HGV 4.x series – these documents cover the entire hydrogen fueling station and various components (dispensers, hoses, compressors, etc.)
- CSA/ANSI standards covering on-board storage of hydrogen in vehicles (HGV 2, HPRD 1, HGV 3.1)
- ANSI/CSA 149.6, *Code for digester gas, landfill gas, and biogas generation and utilization*
- Z662, *Oil and gas pipeline systems* – covers pipeline systems including those for natural gas transportation and distribution, up to the customer's meter set assembly; including applicable component standards:
    - Z245.1, *Steel pipe*
    - Z245.11, *Steel fittings*
    - Z245.12, *Steel flanges*
    - Z245.15, *Steel valves*
- Z341, *Storage of hydrocarbons in underground formations* (series of 3 standards)
- Z276, *Liquefied natural gas (LNG) — Production, storage, and handling*

Other standards that may be impacted on a smaller scale are the pipeline and facilities related ones:

- Z246.1, *Security management for petroleum and natural gas industry systems*
- CAN/CSA-Z246.2-14, *Emergency preparedness and response for petroleum and natural gas industry systems*
- CAN/CSA-Z247-15, *Damage prevention for the protection of underground infrastructure*
- ANSI/CSA Z21-83 appliance, equipment and control standards